

# Robotic Virtual Prototyping Design

## Course at a Glance

The aim of the Robotic Virtual Prototyping Design course is to give the basic knowledge about the Finite Element Analysis (FEA) and Multi-Body Simulations (MBS) applied to the robotics. These computational techniques predict the behaviour of physical systems: joined together permit to study the dynamics taking in account the body flexibility, the control and optimisation. It will be introduced mainly applied to the mechanical field, in particular to the robotics. The student gets 5 credits if he/she attends the entire course and accomplishes the final project.

## Instructors

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## Credits: 5

## Synopsis

Virtual Prototyping Design is the basic part of the Computer Aided Engineering (CAE) that in the last decades involved more and more the R&D of the industries and the Research Centres. The reason is that the physical models need more time and energies for being improved than virtual ones. Moreover, running numerous simulations, these models permit to be optimized depending on several parameters.

Thus the course will give an overview on the virtual prototyping design building the models with the main software (MSC.Nastran, Ansys and MSC.Adams). In the second part of the course, Multibody and Finite Element Analysis will be integrated in order to take the best advantage from the virtual prototyping technique. Then the control (Matlab/Simulink) and the optimization will be applied to the simulations.

Even if the training solutions concern the mechanical problems, it is designed to provide to attendants with both the comprehensive and subject-specific knowledge; the students need to effectively apply software tools to solve general problems: static, dynamic, linear, non-linear and motion or multi-physics analysis. So the aim of the course is not only knowing the performances of the software used to build the basic models, but it is also to be able to improve their skill by themselves.

## Syllabus

**Total of 15 hours - each class is 3 hours.**

- class 1 (C1)
  - Overview on Virtual Prototyping: Finite Element Analysis (FEA) and Multibody Simulation (MBS)
  - FEA using Ansys/Workbench, MSC.Nastran
- class 2 (C2)
  - MBS using MSC.ADAMS
- class 3 (C3)
  - MBS + FEA
- class 4 (C4)
  - MSC.ADAMS + Control
- class 5 (C5)
  - MSC.ADAMS + Control + Optimisation

3 hours will be added for the final examination.

Weekly homework will be assigned at the end of each lecture with an estimated average workload of 3 hours per week. There will be a final examination decided by the instructor.

**Prerequisites**

Basic knowledge of classical physics and programming.

**Reading List**

General references are:

- Klaus-Jurgen Bathe, Finite Element Procedures, Prentice-Hall of India, 2009
- Rajiv Rampalli, Gabriele Ferrarotti & Michael Hoffmann, Why Do Multi-Body System Simulation?, NAFEMS Limited, 2011
- R.J.Del Vecchio, Design of Experiments, Hanser Understanding Books, 1997

**Venue**

Istituto Italiano di Tecnologia, Via Morego 30, Bolzaneto, Genova

**Course dates**

April – May 2015